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A STUDY OF *ECHMATEMYS CALLOPYGE* FROM THE UINTA EOCENE OF UTAH, AND ITS REDEFINITION AS A SUBSPECIES OF *E. SEPTARIA*

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With Two Plates

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No. 6 — *A Study of Echmatemys Callopyge from the Uinta Eocene of Utah, and Its Redefinition as a Subspecies of E. Septaria*

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INTRODUCTION

On September 2, 1953, my field partner Dee A. Hall and I independently located a shell of *Echmatemys* in Uinta Lower C mudstone of Devil's Playground, north of Bonanza, Uintah Co., Utah. We were at the time collecting for the Utah Field House of Natural History in Vernal. The removal of the shell resulted in the discovery of a turtle quarry, which we worked twice during the next summer, uncovering no less than 43 shells and collecting 14. All but one of the latter I identified as *Echmatemys callopyge* Hay; the exception was *E. uintensis.* The second time we worked the quarry in 1954, we noticed that it had become the "mother lode" of the Wampus Cat No. 2 uranium claim in our absence, a fine tribute to the radioactivity of the bone.

During these and other trips to the locality, we also collected five turtles in the near vicinity of the quarry; one was *E. uintensis*, and the others were *E. callopyge*. Subsequently, for the Cleveland Museum of Natural History, I revisited the Wampus Cat No. 2 in 1956 and 1958, and with various assistants removed ten reasonably complete shells and an isolated plastron. Six of the quarry specimens are as yet unprepared, but field identifications indicate that they pertain to *E. callopyge.* The other four are definitely this species. The quarry and its surroundings, then, have yielded 23 to 29 specimens of *Echmatemys callopyge*.

Gilmore (1945) has described a similar *Echmatemys* quarry in Wyoming. The matrix has formed apparently from a pond deposit consisting of reworked volcanic ash and ordinary clay. Although the skeletons were not articulated, the shells were all found right side up.

In the Wampus Cat quarry, the shells were found lying in all possible positions. The matrix undoubtedly was laid down as silt on the bottom of a pond or lake. It may be imagined that the turtles congregated about or within the diminishing margins of a pond that was drying up, and eventually starved. Later, the pond presumably filled up again, and mud flow action on its bottom rolled the shells around and distributed the limb and girdle elements throughout the matrix. Both quarries share the same frustrating lack of skulls and vertebrae.

Mr. Thomas H. Hawisher, a geologist with the Ferro Corporation of Cleveland, has very kindly examined a sample of the Wampus Cat quarry matrix, and his report is as follows (personal communication):

"The rock is best classified as either a highly calcareous mudstone or marlstone. Irregular lumps of clay, fossil fragments, and small, thin sheets of calcite are dispersed in a matrix of argillaceous material and microcrystalline calcite. The matrix itself is mottled as a result of irregular cementation by the microcrystalline calcite.

"The rock is composed almost entirely of two constituents: argillaceous material and calcite. These represent approximately 45 and 50% respectively. The balance consists of quartz, cristobalite, and possibly a number of trace minerals.

"The mineralogical composition of the argillaceous material defies accurate determination by microscopic, x-ray, and differential thermal analysis methods. It is apparently a rather complex mixture of several clay minerals which are perhaps partly amorphous.

"Calcite occurs as three distinct types; microcrystalline ooze mixed with argillaceous material, aggregates of fine crystals, and thin sheets or crusts less than one millimeter thick and oriented variously. These crusts consist of fine calcite crystals whose orientation is not related to bedding planes, thus suggesting precipitation along cracks rather than fossil replacement or lamellar deposition on a bedding surface.

"Quartz is present as angular grains of very fine sand and silt size disseminated throughout the matrix. Cristobalite was not positively identified microscopically but was detected by x-ray diffraction techniques.

"Although it is difficult to speculate on the environment of deposition without a field study, the petrography of the rock suggests some possibilities. The relative proportion of clay and calcite and the lack of coarse grained material suggests slow accumulation in relatively quiet water. This, coupled with the fact that the Uinta Formation is a terrestrial deposit, indicates that the environment was a fresh water lake. Perhaps it was a lake developed on the flood plain of a large river, but it is impossible to be certain without detailed mapping.

"The presence of cristobalite raises the possibility that (like at the Wyoming quarry) there may have been volcanic activity at the time of deposition. However, with the exception of the cristobalite, evidence of volcanism such as glass shards, crystal fragments, etc. is lacking. It is perhaps best to assume that the cristobalite represents material brought in with the quartz and argillaceous material as detritus from an older source area or as wind blown sediment from a far distant area of volcanic activity.''

The only fossil remains observed at the Wampus Cat quarry which were not of a chelonian nature were two small crocodilian teeth and a fragmentary crocodilian scute.

Aside from Devil's Playground, some energetic and dedicated associates and I collected a large number of specimens of *Echmatemys callopyge* at several localities between 1952 and 1959. These are presently in the collections of the Utah Field House, the Museum of Comparative Zoology, and the Cleveland Museum of Natural History. The quarry specimens are housed at the three above-mentioned institutions plus the American Museum of Natural History and Upsala College. Counting the type at the American Museum, a specimen at the United States National Museum, and four at the Carnegie Museum, the total number of individuals which I have examined is an amazing 54. There are also two series of limb and girdle elements from the matrix of the quarry. As might be expected, many of the shells are more or less incomplete, but all have contributed to this study. All specimens are from B and C members of the formation. Due to crushing and distortion in many of the specimens, the measurements used are not necessarily exact, but I believe they are close enough to render the conclusions derived therefrom undeniable.

The similarity between Hay's species and *Echmatemys septaria* from the Bridger Eocene of Wyoming suggested a close comparison between the two long-standing forms. The results of my investigation strongly indicate that the two are actually cospecific, but that the Uinta turtle is a subspecies of the Bridger one.

COMPARISON OF *E. CALLOPYGE* AND *E. SEPTARIA*

Hay (1908) described *Echmatemys callopyge* from a single shell in the American Museum of Natural History, No. 2087. He characterized it primarily on the proportions of the first vertebral scute and the formation of the plastron's anterior lobe (p. 341).

"The anterior lobe is slightly contracted just in front of the axillary notch; then expands a little to the ends of the epiplastra; then curves slowly to the truncated lip. The latter is unusually narrow . . . being less than one-fourth of the width of the anterior lobe. It is markt outwardly on each side by a stout tooth, mesiad of which there is a notch . . . On the upper side of the bone there is, along the midline, a prominent ridge . . . bounded on each side by a valley . . ."

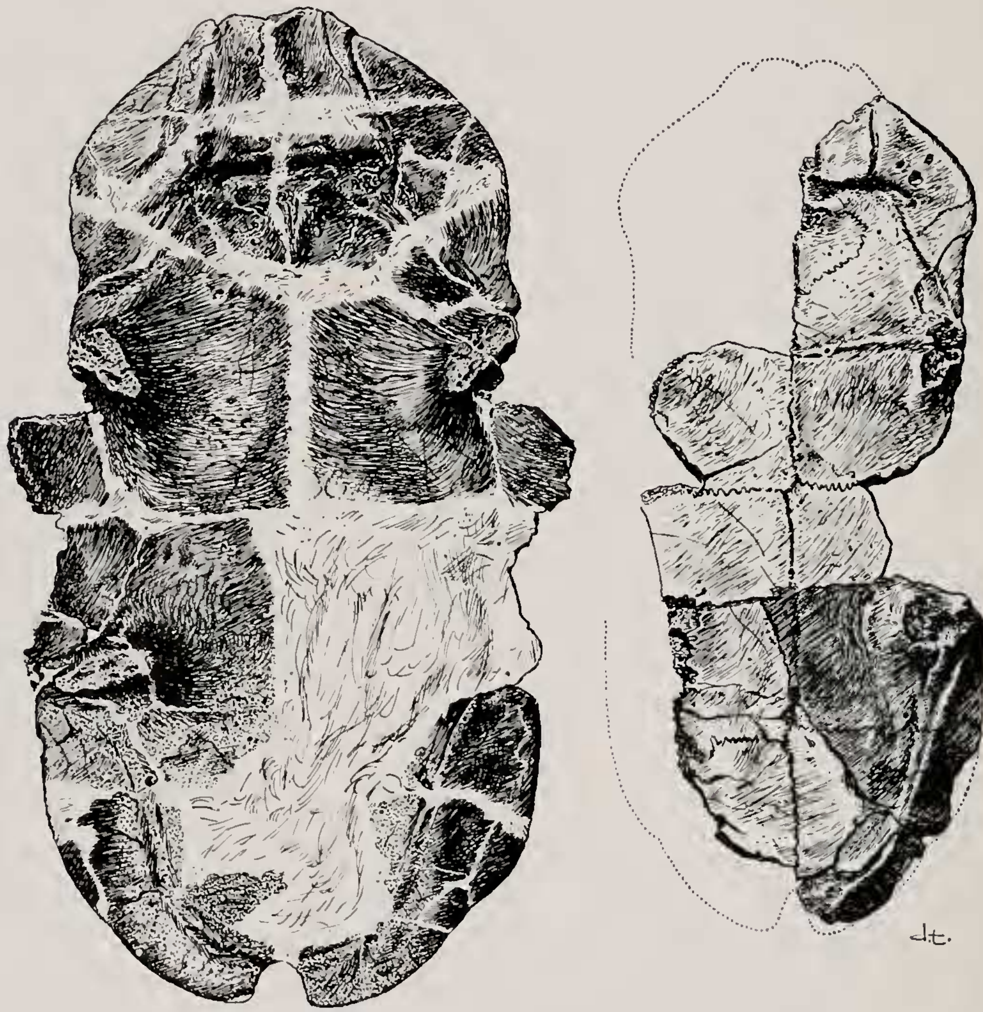

Fig. 1. *Echmatemys septaria*. Internal view of plastron. Left, *E. s. callopyge*, typical specimen (MCZ 2976); right, *E. s. septaria*, type (USNM 4088) (x 1/4).

The first vertebral scute is described by Hay as "unusually narrow"; its length is 139 per cent of its width in the convex central portion. The lateral margins of scutes 2, 3, and 4 are "bracket shaped," and although the scutes are "longer than broad,'' they are ''rather broad.'' The last observation is certainly true when comparison is made with some other species of the genus.

In Hay's opinion, on the basis of the only specimen available, the relative narrowness of the first vertebral scute justified the separation of his new species from all other known members of the genus, while other useful characters were the broad central vertebrals, the narrow epiplastral lip, and the ''longitudinal ridge on the upper side of the symphysis'' of the epiplastrals.

Among the first results of my examination of specimens from the Wampus Cat quarry was the realization that the relative width of the first vertebral scute is quite variable, and therefore is of little value for a specific determination. This conclusion was long ago suggested by Gilmore (1915, p. 125), but since he had only two specimens, he did not change the nomenclature. Collecting in other localities than Devil's Playground has added to the total number of carapaces with the first vertebral preserved, and has proven Gilmore's contention. In 22

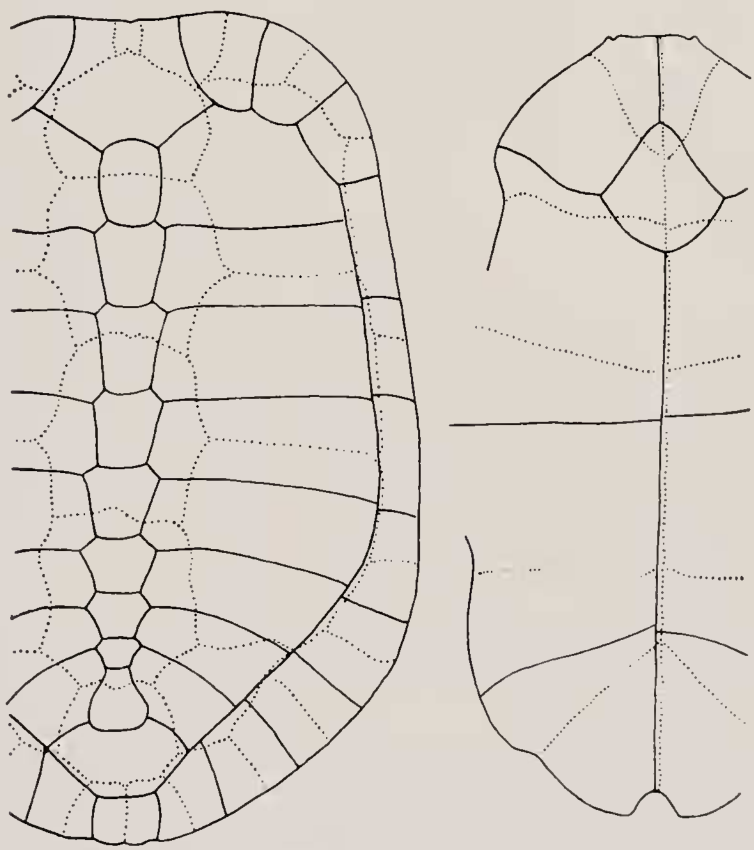

Fig. 2. *Echmatemys septaria callopyge.* Diagram of plastron and carapace of a typical specimen, with relatively wide first vertebral scute. Drawn from MCZ 3125.

adults, not including those mentioned by Gilmore, the length/width ratio varies from 1.39 in the type to 0.81. The mean is 1.10 (Figure 2; Plate 2). In these cases, the width is across the central or posterior convexity, depending upon the shape of the scute.

The other specific attributes mentioned by Hay — the broad central vertebrals, the narrow epiplastral lip, and the median upper ridge on the lip — can all be found in Bridger *E. septaria*. It would appear, then, that there is little basis for the retention of *Echmatemys callopyge* as a distinct species, in the light of information gained from a larger series of shells. All of which again proves Gilmore's oracular prowess. In his Uinta turtle paper (1915, pp. 126, 127), he wrote:

"Had *E. callopyge* not been established, I should have unhesitatingly referred both of the specimens discussed above to *Echmatemys septaria* (Cope). For the present, however, it will serve all purposes to assign them to the established Uinta species . . ."

Hay's description of *E. septaria* is closely comparable to that of his Uinta species, if the first vertebral scute be excepted. What he wrote about the anterior plastral lobe of AMNH No. 6085[1] mirrors the above quoted statements about that area in the *callopyge* type. Hay (1908, pp. 321-322) stated:

"Immediately in front of the axillary notch the lobe narrows a few millimeters, then begins to expand and becomes wider than at the base. At the hyoepiplastral suture the lobe narrows again and passes rapidly to the lip. This is relatively narrow . . . is notcht at the midline, and is furnisht on each side with a blunt tooth. The epiplastrals thicken toward the lip and become 20 mm. thick. For some distance on each side of the symphysis of the bones the thickness is reduced to 15 mm. The lateral expansion of the anterior lobe and the lip form the most distinctive characters of this species."

Hay classified the second and third vertebral scutes as "urn-shaped, expanded in front and narrowed behind." Such a shape, particularly in the second scute, is characteristic of the Uinta turtles as well.

Through the kindness of the Utah Field House, the Carnegie Museum, the American Museum, and the United States National Museum, I have been able to study eleven individuals which,

1 Abbreviations for institutions used in this paper are as follows: AMNH, American Museum of Natural History, New York; CM, Carnegie Museum, Pittsburgh; CLM, Cleveland Museum of Natural History; UFH, Utah Field House of Natural History, Vernal; USNM, United States National Museum, Washington.

in my opinion, all belong to the species *septaria*, and which are from the Bridger Formation. Among these are the type, two of the American Museum specimens studied by Hay, and five from the Levett Creek Quarry in Wyoming reported on by Gilmore (1945). I disagree with Gilmore's identification of the Levett Creek specimens as *Echmatemys wyomingensis* primarily because they show a greater longitudinal development of the epiplastral lip than would appear to be the case in *E. wyomingensis*. Admittedly, the lateral expansion of the anterior lobe in the quarry shells observed is poorly developed when compared with the *septaria* type, but this character is variable in the Utah individuals, so presumably the same holds true for those from Wyoming as well. The shells from the same locality in the Carnegie Museum were identified as *E. septaria*. I am also including an exceptionally fine specimen from the United States National Museum collection (No. 16687) which was labeled *E. aegle*, but which I do not believe can be separated from *septaria* (Plate 1). Such is probably the case with several of the published Bridger species of *Echmatemys*, although a greater knowledge of the Bridger turtle fauna will be necessary to prove or disprove it.

When a comparison was made between the Bridger and Uinta turtles which I studied, in 15 different characteristics, the results fell into three general categories:

1. Little or no difference
   Width anterior lobe at base/length anterior lobe on the mid-line
   Width posterior lobe at base/greatest length posterior lobe
   Distance between epiplastral teeth/width anterior lobe at base
   Width anterior lobe at base/overall length plastron
   Second neural—length on mid-line/greatest width
   Fourth neural—length on mid-line/greatest width
   Third vertebral—length on mid-line/width in middle
   Encroachment of axillary and inguinal buttresses on the plastron
2. Means different, but ranges of variation overlapping
   Length epiplastral lip on upper side/length hyoplastron where it reaches the mid-line
   Length entoplastron on mid-line/greatest width entoplastron
   Length nuchal bone on mid-line/greatest width nuchal bone
   First vertebral—length on mid-line/width in middle
   Second vertebral—length on mid-line/width in middle
3. Means different, ranges of variation barely meeting
   Length epiplastral lip on upper side/length anterior lobe
   Length epiplastral lip on upper side/overall length plastron

The ratios are summarized in Table I.

There is a discernible difference in the plastron length (and other dimensions) of presumed fully mature individuals, with the Uinta form the larger. It seems illogical to consider that all of the six complete *septaria* specimens were smaller than average mature adults, although it is possible, and the small number of plastra measured renders the statistics somewhat questionable. However, the other five specimens, whose plastra were not complete, were similar in size.

The difference which I consider most significant is in the degree of development of the epiplastral lip on the upper surface. This is a characteristic which has been relatively neglected in *Echmatemys,* as in other Eocene turtles, due to the fact that many of the specimens have not had the matrix removed from the insides of the shells. In the turtles of the Uinta Formation, the development of the lip plus the general contour of lip and lobe make identification of the species comparatively easy, even in the field.

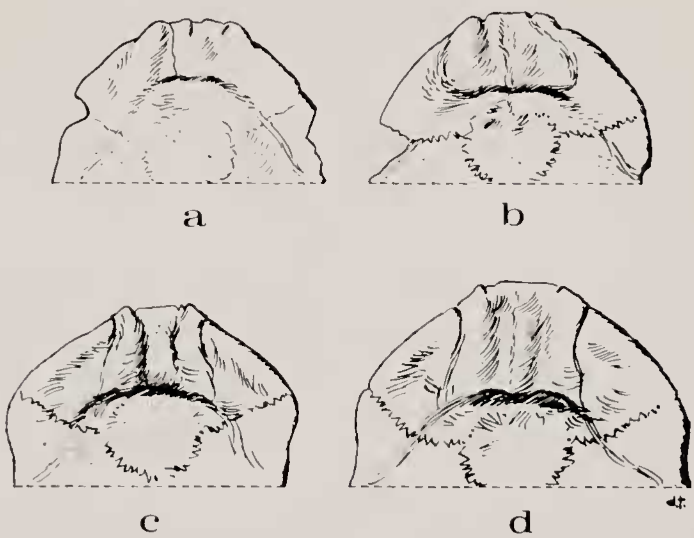

Fig. 3. Epiplastral lip development in *Echmatemys septaria. a,* minimal development, *E. s. septaria* (CM 11923); *b,* medium development, *E. s. septaria* (UFH 228-2); *c,* medium development, *E. s. callopyge* (MCZ 3124 ; *d,* maximal development, *E. s. callopyge* (MCZ 3125) (x ⅕).

When the mid-line length of the thickened lip is related to that of the anterior lobe, or the length of that portion of the hyoplastron which reaches the mid-line, or the overall length of the plastron, it is seen to be relatively greater in the Uinta turtles than in those of the Bridger. This gives a well developed *callopyge* anterior lobe a much more massive appearance than even an above average *septaria*. If a maximal callopyge be compared with a minimal *septaria* in this respect, one might hesitate to call the two the same species, but if a series is laid out, the variants visually as well as statistically grade one into the other (Figure 3). No doubt it is possible that were more specimens available, the ranges of variation in this characteristic would be found to overlap. I believe that the few significant differences between the Wyoming and Utah turtles are best explained as more extreme developments in the latter of characters already found in the former, i.e., the epiplastral lip length and size. Bridger individuals could have migrated into the Uinta Basin through the contemporary (and lower) Uinta Mountains and there could have formed a relatively isolated population, so that by Uinta B times a slightly different shell could have evolved.

All the evidence implies that there is no solid basis for a specific distinction between the Uinta and Bridger forms, although they are not exactly the same. I therefore propose that the Uinta turtle be considered as a subspecies of the earlier described *Echmatemys septaria*.

FORMAL DESCRIPTION

Echmatemys septaria (Cope)

Eocene pond turtles with moderately high carapaces, and plastra up to about 45 cm. in overall length. Anterior lobe of plastron about 1½ times as wide at its base as its mid-line length; width at base somewhat less than half the overall length of the plastron. Anterior lobe usually with a distinct marginal concavity between the base and the hyoepiplastral suture, giving the edge of the lobe a more or less flattened S-curve. Epiplastral lip narrow, and well developed fore and aft on the upper surface, bearing two obtuse longitudinal ridges on the upper surface just mesiad to the gulohumeral sulci; these ridges ending in bluntly pointed "teeth" of varying distinctness. Longitudinal ridge along mid-line of lip on upper side, with shallow valleys between it and the distal ridges. Distance between centers of "teeth" varying from 20 to 40 per cent of width of anterior lobe at the base. Length of lip on mid-line of upper surface roughly 25 to 50 per cent of anterior lobe length, roughly 35 to 70 per cent of length of hyoplastron where it reaches the mid-line, and about 9 to 14 per cent of overall length of plastron.

Entoplastron pear shaped; about as wide as long, or slightly wider. Entoplastron encroached upon at its anterior end by the gular scutes and crossed by the humeropectoral sulcus somewhere on its posterior half.

Width of posterior lobe of plastron at its base 1¼ to 2 times its length; usually considerably less than twice. Xiphiplastra drawn out into narrowly rounded points, often concave medially and convex laterally, but not always.

Carapace with first neural more or less oval, neurals two to seven hexagonal, with the wide ends pointing forward, neural eight variable. Two suprapygal bones. Vertebral scutes two and three more or less urn-shaped, scute three less so than two. First vertebral scute variable in shape. Free borders of central anterior and posterior peripherals acute, with the anterior ones slightly blunter than the posterior ones.

Echmatemys septaria septaria (Cope)

Emys septaria, Cope, 1873, p. 625
Cope, 1882, p. 992
Cope, 1884, pp. 130, 139
Hay, 1902, p. 448
Echmatemys septaria (Cope), Hay, 1906, p. 28
Hay, 1908, pp. 319-323
Echmatemys wyomingensis, Gilmore, 1945, pp. 102-107
Bridger Eocene of Wyoming. Epiplastral lip on upper side is:
ca. 25-40 per cent of length of anterior lobe
ca. 35-50 per cent of length of hyoplastron where it reaches midline
ca. 9-10 per cent of overall length of plastron
Type: USNM No. 4088

Echmatemys septaria callopyge Hay, New Combination

Echmatemys callopyge, Hay, 1908, pp. 340-342
Gilmore, 1915, pp. 123-127
Echmatemys obscura, Gilmore, 1915, pp. 135-139
Echmatemys hollandi, Gilmore, 1915, pp. 133-135
Uinta Eocene of Utah. Epiplastral lip on upper side is:
ca. 40-50 per cent of length of anterior lobe
ca. 45-70 per cent of length of hyoplastron where it reaches midline
ca. 10-15 per cent of overall length of plastron
Type: AMNH No. 2087

DISCUSSION

In the Uinta Formation, *Echmatemys s. callopyge* can be readily distinguished from the other species of the genus, as has been stated above. My acquaintance with a large number of Uinta *Echmatemys* specimens has convinced me that among the turtles collected up to the time of writing, there are no more than four species involved. These are: *septaria, uintensis, douglassi,* and possibly a fourth, represented by incomplete material, which should be considered either as a new species or as a very unusual variant of *E. septaria.*

E. s. callopyge can be separated from *uintensis* and *douglassi* by its greater development of the epiplastral lip; the observed minimum for the subspecies in question is .10 of the overall plastral length, and in the other species the same ratio is .08 in one specimen of each measured. The detailed form of the epiplastral lip is definitely different from that in *uintensis* and *douglassi,* and the anterior lobe is relatively longer than in the latter. The possession of epiplastral ''teeth'' distinguishes *callopyge* tentatively from the possible new species. There are other differences as well, which will be fully covered in a future paper on the Uinta turtle fauna.

E. OBSCURA AND E. HOLLANDI

Two of the species erected by Gilmore in his 1915 paper are most likely to be considered as variants of *Echmatemys septaria callopyge.* These are *E. obscura* and *E. hollandi.* I have carefully examined the types (and only specimens) of each, and in each case have restored for the first time the upper side of the anterior plastral lobe — the feature which, among other things, makes their retention as valid species questionable.

The characteristics of *E. obscura* which set it apart from other species were stated to be: the very narrow nuchal bone, the fact that the gular and pectoral scutes reach the entoplastron, the greater relative widths of the neural bones and vertebral scutes, and the obscure longitudinal ridges on the pleural region of the carapace. A comparison of the type with specimens of *E. septaria* shows that the nuchal bone certainly is unusually narrow, but the vertebrals and neurals are characteristic of *E. septaria,* as is the encroachment of the gulars and pectorals upon the entoplastron. The extreme width of the fourth neural bone shown in Gilmore's (1915) drawing on page 137 is due to his misidentification of the suture on the right side. The bone is only slightly wider than those of provable *callopyge* specimens. Similar ornamentation is observable on the carapaces of a more typical specimen (MCZ 3125) and on CM 3249, the type of *E. hollandi.* MCZ 3131, from the Wampus Cat quarry, shows a beautiful pattern of more obvious ridges both on carapace and plastron.

I have removed the anterior lobe from the matrix, and then conservatively restored the missing portion. It is evident that the lobe and epiplastral lip are characteristically *E. s. callopyge;* the ratio of lip length to length of anterior lobe is close to the mean of other specimens measured.

Thus, the only possible significant difference in the *E. obscura* type is the narrowness of the nuchal bone. However, in view of the anomalies to be found in both Recent and fossil turtle shells, as well as the fact that *obscura* was based upon just a single individual with a nuchal bone longer than wide, but whose every other character can be matched in specimens of *E. s. callopyge*, it seems more appropriate to refer Gilmore's species to the synonymy of *callopyge.*

It seems equally necessary to synonymise *E. hollandi* with *Echmatemys septaria callopyge.* The specific determination was based upon the presence on the first pleural bones of a pair of protuberances shaped like truncated cones, and an associated pair of supernumerary costal scutes flanking the first vertebral. The protuberances are beautifully preserved and obvious, and are, as far as my experience with Uinta turtles goes, unique.

At the time Gilmore's paper was published, there were not many specimens of *Echmatemys* from the Uinta in museum collections, and it was not unreasonable for him to believe that such an amazing specimen might represent a distinct species. However, in five field seasons of varying lengths in the Uinta, neither I nor any of my field partners have seen another such pleural bone. If individuals such as the *hollandi* type were at all common, one would think that at least a few fragments showing the protuberance would have been found. This naturally leads to the conclusion that the type is a very unusual variant of another species.

Considered in this light, the supernumerary costal scutes assume less importance. Analogous extra scutes have been observed in *Baena* (Gilmore, 1915, pp. 114, 118), and other such scutal peculiarities are readily found in living and fossil forms.

The other characteristics of the *hollandi* type appear to be of the *callopyge* habitus. As Gilmore mentioned, much of the anterior lobe of the plastron had weathered away, but a mold of the upper surface of most of the missing portion was preserved in the sandstone filling of the shell. I made a cast from the natural mold, cemented it to the original base of the lobe, and then restored the lobe in a generalized manner. It looks very much like another member of the *callopyge* tribe. The ratio of estimated lip length on upper surface to the estimated length of the anterior lobe is about at the minimum of other specimens measured, and thus could probably be equated with them. It is surely within the variation of the species *septaria* as it is herein defined.

Six other ratios which can be obtained from the shell all fall within the variation of *E. s. callopyge*. These are: the width of the anterior lobe/its estimated length; the length/width of neurals 2 and 4; and the length/width of vertebral scutes 1, 2, and 3. The proportions of the entoplastron cannot be determined with any exactitude because of its incompleteness, but it appears to have been pear shaped, as in all but one of the *callopyge* individuals. It can be seen in Gilmore's drawing that the shapes of neurals and vertebrals are like those of *callopyge* specimens.

I can, therefore, see no valid characters for the separation of *E. hollandi* from *E. s. callopyge*.

The Characteristics of E. s. callopyge

The anterior lobe of the plastron is consistently much wider at its base than it is long, the width being from about 1⅓ to 1½ times the length. The lateral indentation in the lobe's margin is also quite consistent, although its development varies (Figure 4). In some cases, it is as distinct as that of the type and the specimens of *E. s. septaria* figured by Hay (1908). In several cases, however, it is poorly defined, and in at least one is virtually indistinguishable. In spite of the usually obvious lateral swelling of the lobe, the width at the base is in most cases the greatest width. In some, the two widths are the same, and in a few, the central width is the greater.

The epiplastral lip varies from decidedly prognathous to extending little if at all from the contour of the lobe (Figure 4), but in all specimens in which it was preserved, its configuration was as defined above. Its thickness ranges from slightly less than a centimeter to almost two centimeters in adults; this is due in many cases to the fact that some are more crushed than others, but there is evidence that the thickness did vary in life. The epiplastral "teeth" sometimes blend gradually into the margin of the lip, and sometimes are well defined by a mesial groove or emargination; occasionally, there are one or more tiny supernumerary points between the "tooth" and the main body of the lip (as in the type).

The fore-and-aft development of the epiplastral lip is unusually great for an emydine turtle, the minimum length being 10 per cent of the overall plastral length, with a mean of 12 per cent. The same ratio in twelve Recent and fossil emydines ranges from 1 to 10 per cent (Table III). As Hay mentioned, the anterior width of the lip is also unusually small. It appears to be characteristically slightly over ¼ the width of the base of the anterior lobe.

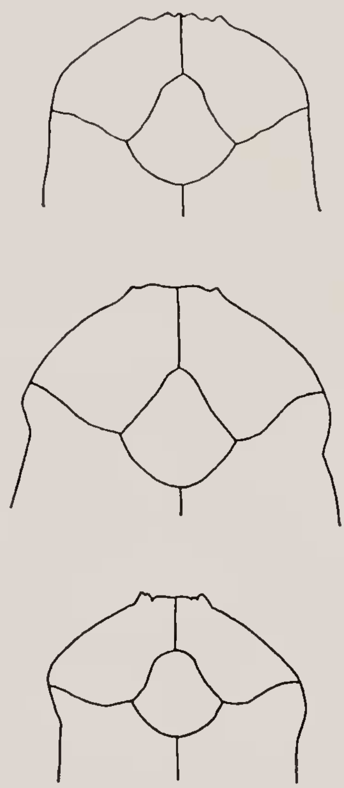

Fig. 4. *Echmatemys septaria callopyge.* Diagrams of three anterior plastral lobes, external view, showing variation in lobe margins and shapes of entoplastra.

The entoplastron is invariably more or less pear shaped, and its greatest length and greatest width are always close. The humeropectoral sulcus crosses it at all levels from its widest section to its posteriormost point, but in the majority of individuals, the sulcus crosses roughly halfway between those levels. Many, but not all, of the cases in which the sulcus is at or near the posterior point of the entoplastron are immature shells.

The posterior lobe of the plastron in well preserved specimens differs little from that of the type. Its basal width is usually around $1\frac{1}{2}$ times its greatest length, although the range of variation is from less than $1\frac{1}{4}$ times to twice. The most obvious variation is in the xiphiplastral points, which are found to range from distinctly concavo-convex to convex on both lateral and mesial margins.

The bases of the inguinal buttresses cover more of the plastron's width than do the axillaries, but the latter are well developed. The axillaries extend from 20 to 40 per cent of the way from the axillary notch to the mid-line, and the inguinals extend from 40 to 60 per cent. The inguinals are in all cases observed along the suture between pleurals 5 and 6, being mostly on pleural 5. They rise in adults to within 2 cm. of the rib-head on pleural 5. The axillaries in every case are fused to pleural 1, and form a continuous ridge with its rib-head.

The nuchal bone varies greatly in width, particularly in the *obscura* type, in which the length is 130 per cent of the greatest width. The minimum ratio is 68 per cent. The mean is 85 per cent, which would probably be close to the "normal" maximum were the *obscura* type excepted.

The first neural bone is consistently oval or sub-rectangular. Neurals 2 through 7 are regularly hexagonal, with the wide ends facing forward. In the series, the widths show no pattern at all; the widest may be any one from neural 2 to neural 7. There is more regularity in the lengths, however. The third neural is almost always the longest of the hexagonal ones, and the next longest is usually the fourth, but may be the second

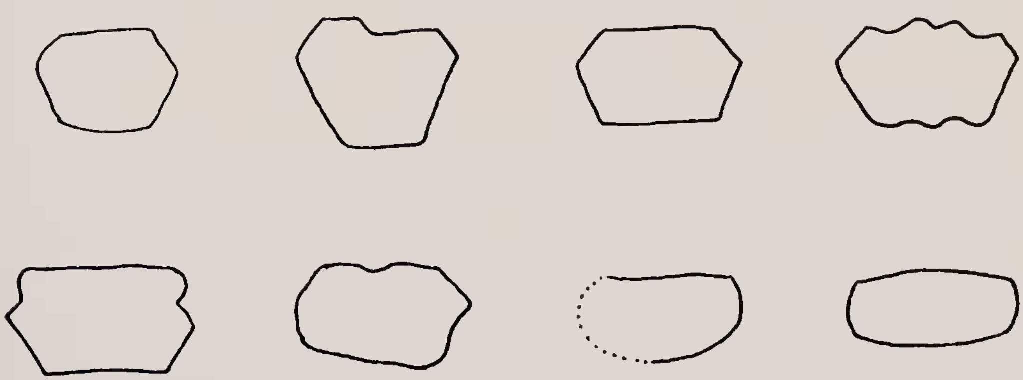

Fig. 5. *Echmatemys septaria callopyge.* Variation in shape of eighth neural bone.

or fifth. The most common order from longest to shortest is 3-4-2-5-6-7-8. The eighth neural varies greatly in shape, but is no doubt to be considered basically hexagonal like the others (Figure 5).

The first vertebral scute, as mentioned above, is inconstant in proportions, with that of the type being the narrowest (length 139 per cent of width). The range of the same ratio in other specimens is from 84 to 127 per cent. The second vertebral scute appears to be always more or less urn-shaped, with its lateral borders distinctly curved. In some cases, the length on the mid-line and greatest width are about equal, but mostly the scute is up to 25 per cent wider than long. The third vertebral is also urn-shaped, but its lateral margins, while having the shape of brackets, are straighter than those of the scute in front of it. It oftener has the length and width about equal; the mean length/width ratio is 1.04.

Two of the specimens studied have extra components. The supernumerary costal scutes of the *hollandi* type are discussed above. A fragment from the Wampus Cat quarry shows the suture of an extra posterior peripheral bone which occupies portions of the pygal and its contiguous peripheral on the left side (Figure 6).

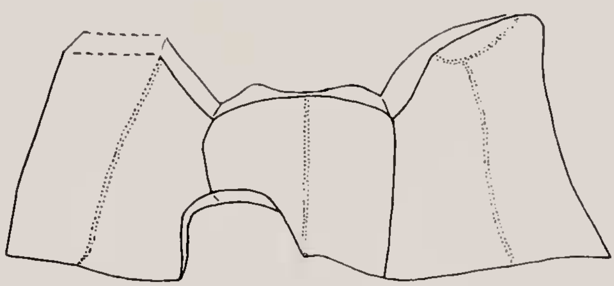

Fig. 6. *Echmatemys septaria callopyge.* Diagram of pygal and posterior peripherals, showing suture for supernumerary peripheral (MCZ 3145).

Growth Pattern

Fortunately, several immature specimens have been collected, and while they are in most cases rather incomplete, the growth pattern is indicated in three respects. Taking the type as an example of a full-grown mature individual, the smallest shell is about ⅕ the adult size. The Uinta fossils have been compared with a series of *Chrysemys picta marginata* from Cuyahoga Co., Ohio, in the Cleveland Museum collection, and a comparison is shown in Table II. Naturally, the vertebral scutes become relatively narrower in both species with advancing age. In *Chrysemys*, the epiplastral lip lengthens slightly in the growth series, but the figures on *Echmatemys s. callopyge* are inconclusive. They suggest that the development of the lip is the same in young individuals as it is in old ones (Figure 7). In *Chrysemys*, the anterior lobe lengthens greatly relative to its basal width as the animal grows; the proportions in *E. s. callopyge* appear to change in the same direction, but to a lesser degree.

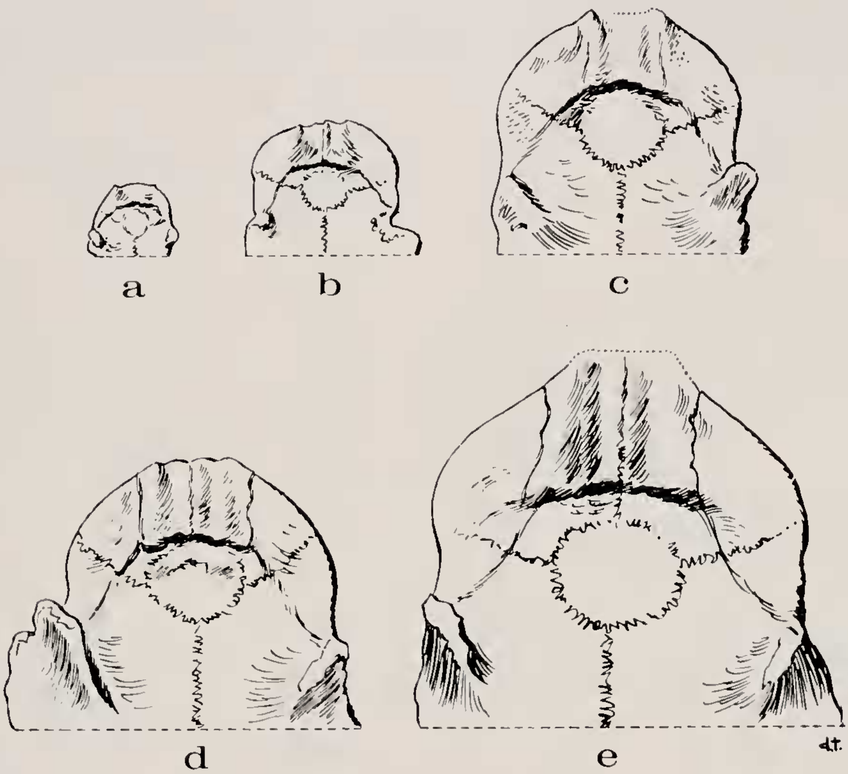

Fig. 7. *Echmatemys septaria callopyge.* Growth series. *a*, MCZ 3149, smallest specimen collected; *b*, MCZ 3133; *c*, CLM 10919; *d*, MCZ 3138; *e*, MCZ 3128 (x ¼).

In young individuals of the Uinta subspecies, the shapes of the vertebral scutes and particularly the configuration of the anterior lobe of the plastron bear the stamp of *callopyge*, and are readily identifiable. The scutes, of course, are less mature in their development in that they are considerably wider than long. The smallest specimen studied (MCZ 3149) exhibits a well developed epiplastral lip. The ratio of lip length to length of hyoplastron at the mid-line (.47) is within the range of variation of adults, and the ratio of lip length to anterior lobe length

(.35) is only slightly below the adult minimum. In comparison, an *Echmatemys* cf. *wyomingensis* shell of similar size (AMNH 6153) furnishes corresponding ratios of .18 and .16.

In the specimen MCZ 3149, the entoplastron is diamond shaped instead of pear shaped; whether this is an individual variation or an indication of youth is unknown.

Limbs, Girdles, and Vertebrae

A small number of bones of the appendicular and axial skeletons have been collected, the bulk of which belong with specimens MCZ 3125 and CLM 10627, or come from the matrix of

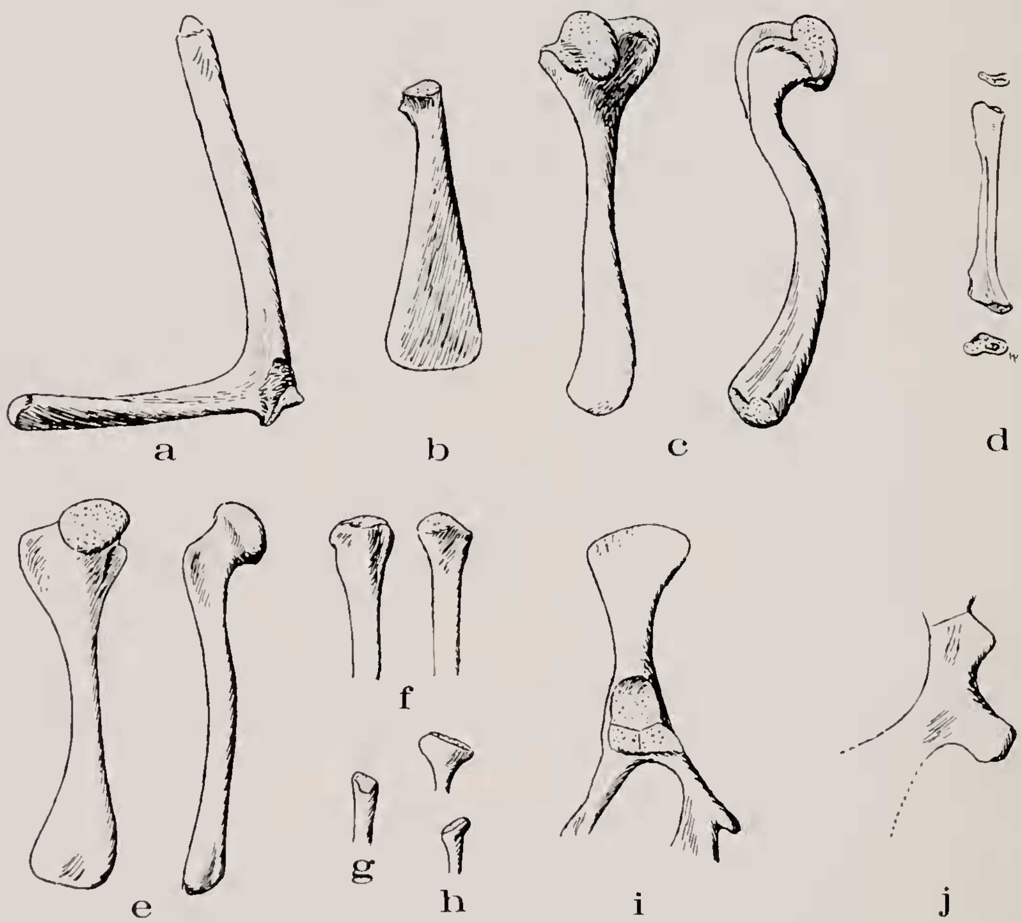

Fig. 8. *Echmatemys septaria callopyge.* Limb and girdle elements. *a*, left scapula (MCZ 3125); *b*, left coracoid (MCZ 3125); *c*, left humerus (MCZ 3147); *d*, right radius (MCZ 3126); *e*, left femur (MCZ 3125); *f*, left tibia (MCZ 3125); *g*, presumed proximal end of left fibula (MCZ 3125); *h*, sacral rib (MCZ 3125); *i*, right pelvis, restored from MCZ 3125 and 3129, and CLM 10627; *j*, upper side of left pubis, restored from MCZ 3125 and CLM 10627 (x ½).

the Wampus Cat quarry. The femur, humerus, radius, and pectoral girdle have been completely preserved, and the pelvis can be restored except for the distal portions of the pubis and ischium. Partial tibiae, fibulae, and ulnae have been found, as well as sacral ribs, some caudal vertebrae, and two cervical vertebrae. Not a scrap of skull or jaw has turned up.

These elements compare well with their counterparts in the Painted Turtle, *Chrysemys picta.* The ratios of limb bone lengths to plastron lengths are similar in both, as are the basic shapes. These facts plus the relative delicateness of the limb bones show that the legs of *Echmatemys septaria callopyge* were no better developed than are those of the modern Painted Turtle.

One of the cervical vertebrae is most probably a fourth; it appears to be narrower anteriorly than the fourth in *Chrysemys*, but otherwise resembles it. The other cervical is a characteristic eighth.

Hay (1908, p. 297) illustrated a series of limb and girdle bones presumed to pertain to *Echmatemys.* The similarities between these and the *E. s. callopyge* material are obvious, and the differences are minor. In view of the paucity of such fossils, I see no reason for a detailed comparison at this time.

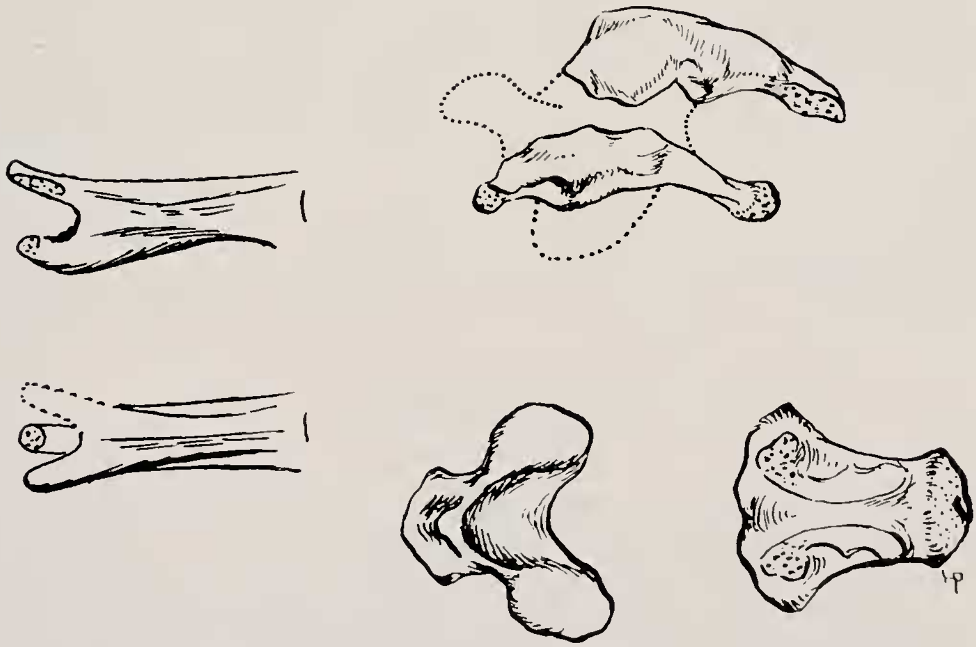

Fig. 9. *Echmatemys septaria callopyge.* Cervical vertebrae. Left: fourth cervical, right side and top view (MCZ 3129). Right: eighth cervical, left side (ventral process and sides of neural canal broken away) and top views of neural arch and centrum (MCZ 3126) (x 1).

It can be said that the known skeletal elements of *E. s. callopyge* are not unusual for an emydine turtle, and match those of Recent pond turtles. The anatomy of the Uinta subspecies herein described plus the petrology of the Wampus Cat quarry lead to the conclusion that *callopyge* probably matched in appearance and habitat the Painted Turtle of today, although, of course, it was much larger.

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TABLE I

PROPORTIONS OF CARAPACE AND PLASTRON IN ADULTS

		Max.	*Min.*	*Mean*	*No. of Measurements*
Length epiplastral lip on mid-line/ overall length of plastron					
	callopyge	.14	.10	.12	11
	septaria	.10	.09	.09	5
Length epiplastral lip on mid-line/ length anterior lobe					
	callopyge	.50	.36	.40	18
	septaria	.36	.27	.32	9
Length epiplastral lip on mid-line/ length hyoplastron where it reaches the mid-line					
	callopyge	.71	.43	.58	17
	septaria	.49	.35	.41	9
Width anterior lobe at base/length anterior lobe on mid-line					
	callopyge	1.61	1.24	1.43	21
	septaria	1.58	1.30	1.45	10
Width anterior lobe at base/overall length of plastron					
	callopyge	.50	.38	.43	22
	septaria	.48	.38	.42	7
Distance between epiplastral teeth/ width anterior lobe at base					
	callopyge	.40	.20	.28	21
	septaria	.36	.22	.28	9

Table I (Cont.)

		Max.	Min.	Mean	No. of Measurements
Width posterior lobe at base/ greatest length posterior lobe					
	callopyge	2.10	1.16	1.44	14
	septaria	1.50	1.25	1.33	7
Second neural: length on mid-line/ greatest width					
	callopyge	1.21	.90	1.02	15
	septaria	1.22	.97	1.10	9
Fourth neural: length on mid-line/ greatest width					
	callopyge	1.36	.95	1.11	17
	septaria	1.37	.97	1.10	8
First vertebral: length on mid-line/ width in middle					
	callopyge	1.39	.81	1.10	22
	septaria	1.05	.74	.87	8
Second vertebral: length on mid-line/width in middle					
	callopyge	1.03	.63	.88	23
	septaria	1.25	.98	1.09	8
Third vertebral: length on mid-line/ width in middle					
	callopyge	1.22	.83	1.04	17
	septaria	1.22	1.03	1.12	8
Nuchal bone: length on mid-line/ greatest width					
	callopyge	1.30	.68	.85	7
	septaria	.85	.63	.73	8
Length entoplastron/greatest width entoplastron					
	callopyge	1.08	.91	1.02	19
	septaria	.98	.73	.88	10
% of lobe base occupied by buttress					
	callopyge				
	axillary	40	17	29	15
	inguinal	60	40	56	12
	septaria				
	axillary	39	29	34	2
	inguinal	53	40	48	3

Table II

Growth Series

	A	B	C	D	E
Chrysemys picta marginata					
CLM ZF 1492	2.3	.043	5.0	.33	.33
1490	7.2	.056	2.2	.52	.50
251	9.7	.062	1.9	.66	.61
1302	14.0	.064	1.8	.70	.66
Echmatemys septaria callopyge					
MCZ 3159	9.0*	——	1.7	.59	.66
3132	16.7	.123	1.8	.68	.82
3125	39.0	.136	1.5	.82	1.00
AMNH 2087	42.0	.114	1.5	1.01	1.06

A—Overall length of plastron in centimeters
B—Length of epiplastral lip on mid-line/length of plastron
C—Width anterior lobe at base/length anterior lobe on mid-line
D—Second vertebral — length/width
E—Third vertebral — length/width
* Estimated

Table III

Epiplastral Lip Development in Emydines

Length of epiplastral lip on mid-line/overall length of plastron

Species	*Ratio*	*No. of Specimens*	*Catalog Nos.*
Graptemys sp.	.01	1	**
Pseudemys scripta cataspila	.03	7	MCZ 46389-91 46394-96 46398
Echmatemys wyomingensis	.04	1	CLM 10181
Terrapene carolina	.05	2	CLM ZF 1240, **
Chrysemys picta marginata	.06, .07	2	CLM ZF 1302, **
Emydoidea blandingii	.06, .07	2	CLM ZF 839, **
Clemmys insculpta	.07	1	CLM ZF 477
Echmatemys uintensis	.05, .08	2	UFH 214, 223
Echmatemys douglassi	.08	1	UFH 205
Pseudemys scripta scripta	.08	1	CLM ZF 484
Clemmys guttata	.09	1	CLM ZF 506
Echmatemys septaria septaria	.09–.10	5	
Echmatemys septaria callopyge	.10–.14	11	

** Specimen belonging to the author